

Inside INEEL

An inside look at the Idaho National Engineering and Environmental Laboratory

A facility managed and operated by Bechtel BWXT Idaho, LLC



INEEL and Bechtel Telecom collaborate on Wireless Testbed

Cell towers are sprouting up all over the American landscape like produce in a well-tended garden, seeded by the enormous increase in cell phone use. A March 2002 study reported a 29 percent growth rate for cell phone ownership over the previous two years, with 62 percent of American adults owning a cell phone.

These increases in usage and capabilities are not without their growing pains, both for commercial

vendors and the public. Problems range from interference and service interruption to troubles with network integration and handset interoperability. The costs and complications of solving some of these problems can be immense. But the U.S. Department of Energy's Idaho National Engineering and Environmental Laboratory and

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From the Editor...

One mark of a national laboratory is to develop technologies and apply science to address the nation's "grand challenges" and address real-world problems that have national impact.

This issue of the *Inside INEEL* contains stories that illustrate the INEEL's continuing, and growing, contributions to solving those grand challenges in national security, energy security, and environmental challenges using state-of-the-art research.



The Wireless Testbed offers large-scale, independent, end-to-end testing of wired and wireless next-generation communication infrastructure to commercial and government entities.

Stepping up cleanup The Idaho Completion Project

In the past year, the U.S. Department of Energy's Idaho National Engineering and Environmental Laboratory's Environmental Management program has made remarkable strides. Employees made steady progress in reducing the volume of liquid radioactive waste at the Idaho Nuclear Technology and Engineering

Center tank farm; in consolidating spent nuclear fuel into safer storage; in completing the shipment of 3,100 cubic meters of transuranic waste to the Waste Isolation Pilot Plant in New Mexico; and in performing work on several other cleanup remedies at various site facilities.

The purpose of the environmental management program is to reduce or

eliminate the risks posed by contamination and waste left at the INEEL from past missions while protecting workers, the public and future generations.

In February 2002, the DOE published the Top-to-Bottom Review for the Environmental Management Program across the nation. The report concluded that cleanup efforts needed to be restructured. The efforts are to be refocused on reducing or eliminating environmental risk as quickly as

possible without compromising protection of the public.

In July, DOE-Idaho followed the report with the "Environmental Management Performance Management Plan for Accelerating Cleanup of the Idaho National Engineering and Environmental Laboratory." The plan details the current conditions at the

See **Cleanup** page 4

Trucks line up to haul transuranic waste out of Idaho. The INEEL met its commitment to the state two months early.



Doing more than humanly possible

Initiatives under way at the U.S. Department of Energy's Idaho National Engineering and Environmental Laboratory apply to the real world in ways you might not expect.

Whether you are a process or production manager, environmental planner, elected official, police officer or soldier—and work in an office, production plant or on the battlefield—you can expect to be influenced by work conducted at the INEEL. You'll be able to get your act together, be more secure and operate safely, accomplish higher-quality work, and make better decisions without hassles and stress.

"It's great to have confidence that we can now accomplish things that were once considered impossible," said Bruce Hallbert, manager of INEEL's Human Factors, Robotic & Remote Systems Department.

"The new knowledge, ideas and science-based concepts that our people develop to improve the way humans work with and use computers and automated equipment is evidence we have crossed the threshold into a new and thrilling 'human machine' frontier – where people and machines team up to literally do more than is humanly possible," Hallbert said.

"This is fun. It really is," said Harold Blackman, INEEL associate laboratory director. "For more than



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20 years, our people have possessed the go-to-human factors-and-engineering expertise to help the government train and safely operate nuclear reactors and use robotic systems to protect workers in hazardous environments.

"Now we're finding ways to share these skills with others," Blackman said. "And since we have the largest group of human factors, systems and robotic professionals within the DOE complex—we created what we call the 'Intelligent



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Human/machine interfaces improve human performance, productivity, safety and security (above). 3-D training scenarios are tailored for specific instruments and stress conditions (left). User-friendly software and hardware configurations help emergency responders make time-critical decisions (far left).

ing with fellow robots to avoid collisions and duplicate effort.

Initiative researchers and engineers frequently collaborate with universities and a variety of government agencies. Among these are the Department of Defense—in the area of intelligent systems for military infrastructure and national security interests—and NASA, for whom we developed human reliability assessment and training tools. Other clients include agricultural, mining, energy, environmental, and science and technology interests.

(For more information, call Reuel Smith, 208-526-3733.)

A safe step closer to clean fuel

Supercritical solvent is key to ultra clean fuels

Chemical engineer Daniel Ginossar and his team at the INEEL are solving a big national problem—the need for clean burning fuels for our cars.

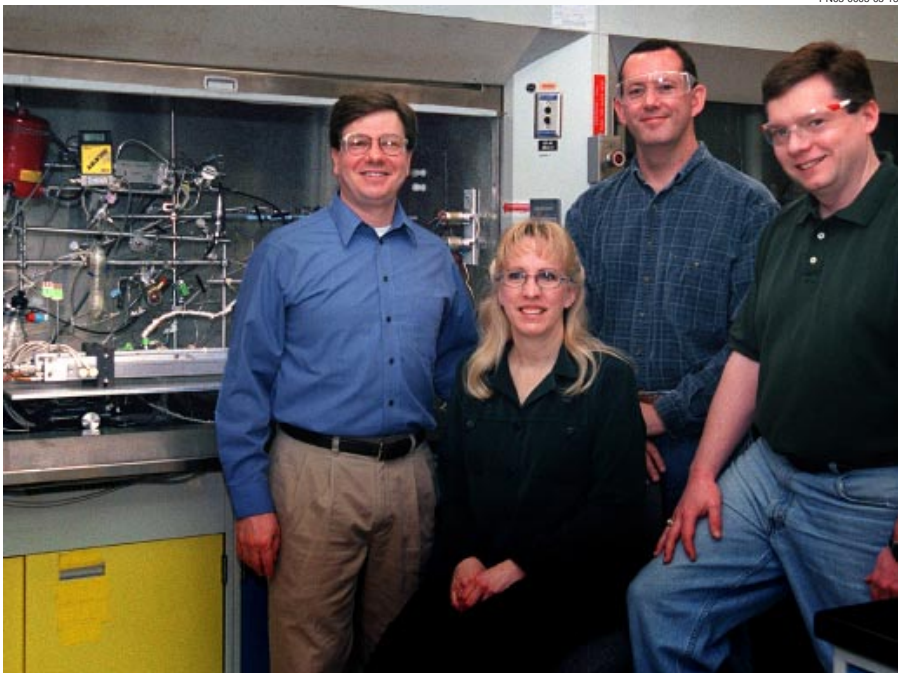
Today, high-octane ultra clean fuel called alkylate comprises only 13 percent of the nation's gasoline because the production process, alkylation, is risky. Alkylation uses dangerous liquid acids that pose a serious hazard to workers through skin contact and inhalation, and to surrounding communities through the threat of a toxic acid vapor cloud or spill. Fifty or more years ago, when most such refineries were built, they were located in areas with little or no population—but today, they're in the middle of urban environments that have grown up around them. As a result, it is extremely difficult to permit new plants or expand existing facilities.

To address this, industry began experimenting with solid acid granules, called catalysts, to create

alkylate. The material is as harmless as sand or clay, but gets coated with a tar-like substance. As a result, it only lasts for three to five hours, making it too expensive to use. INEEL's process, Solid Alkylation Catalyst Regeneration, not only cleans the catalyst but makes it last 70 times longer.

The team's approach takes advantage of a chemical already in the raw gasoline feed called isobutane. They heat and pressurize the isobutane and coax it to act a little like a liquid and a little like a gas so that it seeps into the nooks and crannies to clean the porous catalyst.

Using this very safe technology, industry can eliminate the risks of storing, disposing or transporting dangerous liquid chemicals, as well as the risks of chemical spills. "Our innovative solution will enable the addition of new alkylation plants or expansion of existing facilities to dramatically improve production capacity and costs of this important



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INEEL's clean fuel team: (from left to right) Daniel Ginossar, Kyle Burch, Robert Fox, David Thompson.

refining process," said Ginossar. Ginossar is already working with a major U.S. refining company, and is discussing the technology with an alkylation technology company. The

U.S. Department of Energy's office of Fossil Energy funded this research.

(For more information, call Deborah Hill, 208-526-4723.)

Jellyfish gene helps researchers study bacteria

Colorful microbe marker technique benefits environmental research

With the help of a gene plucked from a northern Pacific jellyfish, INEEL microbiologist Joni Barnes makes bacteria glow fluorescent green under the probing light of a

microscope. And that makes the microbes easier to study.

The green fluorescent protein, which is part of the jellyfish light

system, was cloned about 10 years ago and has been widely used in medical research. Barnes is developing techniques to use the protein in bacteria found in the environment. She also has experimented with jellyfish genes that produce blue, cyan and yellow fluorescence and a red color derived from a sea anemone. Using multiple colors makes it possible to decode who's who in a mixed population of bacteria.

The color-coding technique takes advantage of bacterial plasmids. Plasmids, which occur naturally in bacteria, are small molecules of DNA that are separate from the bacterial chromosome. In nature, plasmids often encode proteins that protect microbes from toxins such as antibiotics or heavy metals. So Barnes inserts the jellyfish gene into one of these plasmids, the newly 'tagged' bacteria start making fluorescent proteins and then the science can begin.

Barnes is using the technique to study how microbial populations live and relate to their surroundings. The colored tags allow her to detect and track the bacteria. These types

of studies could lead to new bioremediation strategies for many sites contaminated with radionuclides, heavy metals or chlorinated solvents. So far, she's successfully tagged several different species of bacteria that naturally break down iron, sulfate and nitrates. These types of microbes influence the mobility of contaminants in the environment.

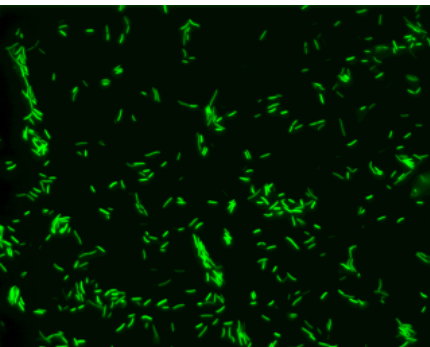
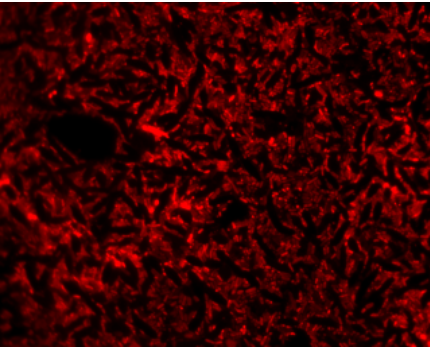
The colors give researchers the ability to customize their experiments. "We can use colors that offer the best visual contrast with the background," Barnes said. "For example, in mineral samples that appear yellow under epifluorescent light, a blue glowing bacteria would be more easily detected than yellow."

One of Barnes' goals is to define the advantages and limitations of the fluorescent proteins under environmental conditions. She plans to apply her techniques to both laboratory and field studies and to biosensor development. Biosensors are instruments that use biological molecules to detect other biological molecules or chemical substances.

This research is funded by the INEEL's Laboratory Directed Research and Development (LDRD) program.

(For more information, call Deborah Hill, 208-526-4723.)

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Joni Barnes studies some of her color-coded bacteria in a microscope. Multiple colors make it possible to decode who's who in a mixed population of bacteria, such as e. coli (top) and Shewanella putrefaciens (bottom).

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'We built flexibility right into the Testbed infrastructure,' said Lynda Brighton, INEEL Testbed project engineer. Steve Williams, INEEL communications system designer, said, 'We designed the system so that customers can just 'plug-in' their equipment and go.'

Wireless Testbed

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Bechtel Telecommunications have a tool to help overcome these obstacles – the Bechtel/INEEL Wireless Testbed.

Built on the INEEL in cooperation with Bechtel Telecommunications and Bechtel National, the Testbed offers large-scale, independent, end-to-end testing of wired and wireless next-generation communication infrastructure including 3G/4G cellular, land mobile radios and wireless local area network systems.

"We wanted to create an environment to allow carriers and manufacturers of next generation equipment to bring it in and test it end-to-end," said Lynda Brighton, INEEL project engineer. "Test, characterize and troubleshoot their equipment free from interference with current systems, free from disrupting current customers, and free from competitors' eyes."

While this sounds like the standard step in any engineering design process, it hasn't been done because it couldn't be done. No facility existed where wireless communications could be tested in a life-size, city-like setting. Laboratory or bench-scale tests had to suffice.

Over the past several months, the INEEL/Bechtel team of researchers and engineers has constructed three cell towers on the INEEL site and has provisioned them with various

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Over the past several months, the INEEL/Bechtel team of researchers and engineers has constructed three cell towers on the INEEL site.

radio equipment, test equipment and modeling/simulation tools to the tune of more than a million dollars.

The Testbed opened for business April 1, and preliminary equipment testing by commercial companies has already begun. The INEEL is concentrating on government customers and their national security issues such as emergency and 911 calls, and wireless system vulnerabilities.

(For more information, call Kathy Gatens, 208-526-1058.)

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INEEL engineer designs video camera for chem/bio response teams

An engineer at the U.S. Department of Energy's Idaho National Engineering and Environmental Laboratory has designed a nifty tool to help emergency response and civil support team members "see" a little better – the Hazmat Cam.

Hazmat Cam is a lightweight wireless video camera system that emergency team members carry to the incident scene. Housed in a tough, waterproof flashlight body about eight inches long, the camera system sends back real-time images to a video monitor, or computer at a command post located up to several miles from the incident area.

"I've listened to the different chem/bio teams during training exercises and at meetings and conferences," said system designer Kevin Young. "The most

important requirement for a camera is clean, clear, reliable video."

Young attributes Hazmat Cam's fidelity to its triple-antenna, true-diversity receiver. The Hazmat Cam receiver seeks the strongest signal from each of the three antennas and locks in this signal. It completes this scan over 1,000 times per second, much faster than a human viewer would notice. This triple-diversity receiver results in a clear, more reliable image even under less-than-perfect conditions, such as within metal buildings or concrete tunnels.

Hazmat Cam has other features that distinguish it from existing systems. Extension Link is a separate transmitter-and-receiver system that increases the operating range of Hazmat Cam two to three miles.

Housed in a tough, waterproof flashlight body about eight inches long, the Hazmat Cam sends back real-time images to a video monitor.



Lately, Young has been testing a teleconferencing method to transmit the Hazmat Cam's video signal.

The current version of Hazmat Cam also includes optional encryption so that, according to Young, electronic news media can't pick up the transmission and broadcast it on the evening news. This doesn't mean, however, that the transmission can't be shared among cooperating agencies. Agencies on the scene with properly configured Hazmat Cam

receivers can all receive the same video transmission.

Interest in the Hazmat Cam has grown recently throughout the nation, with sales to a wide array of customers, including state civil support teams, the U.S. military and government.

(For more information, call Kathy Gatens, 208-526-1058.)

Hazmat Cam has been used in National Guard Civil Support Team field exercises throughout the country.



Cleanup

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INEEL, the expected end states, and the management processes required to meet them. The goal is significant risk reduction—with all materials in safe storage and ready for disposal by 2012—and all active cleanup work completed by 2020 or earlier.

To implement the Performance Management Plan with its overarching goal of integrating and completing all remaining cleanup activities, a new project was created called the Idaho Completion Project. The structure of the ICP addresses DOE's highest environmental management priorities at the INEEL. It gears staffing, budgets and actions toward completing jobs on an accelerated schedule. It consists of six subprojects, each having a specific work scope designed to achieve goals related to reducing risk and accelerating cleanup:

- Clean and Close the Idaho Nuclear Technology and Engineering Center
- Clean and Close the Radioactive Waste Management Complex
- Clean and Close Test Area North
- Complete the Balance of INEEL Cleanup
- Eliminate Mixed Low-Level Waste Backlog
- Transfer Spent Nuclear Fuel and Close Basins

As the project is implemented, regulators and stakeholders will be involved to further accelerate cleanup activities. These relationships are essential for meeting the project's goals.

Decontamination, decommissioning and dismantlement of outdated INEEL facilities is a key component of accelerating risk reduction and achieving cost savings.

The Idaho Completion Project puts the INEEL in the strongest possible position to eliminate and reduce risk as quickly as possible without compromising protection of workers, the public and the environment. The project stabilizes, disposes of waste

and completes cleanup much sooner than previously planned, up to 35 years in some cases, and saves up to \$19 billion in avoided costs.

(For more information, call Stacey Francis, 208-526-0075.)

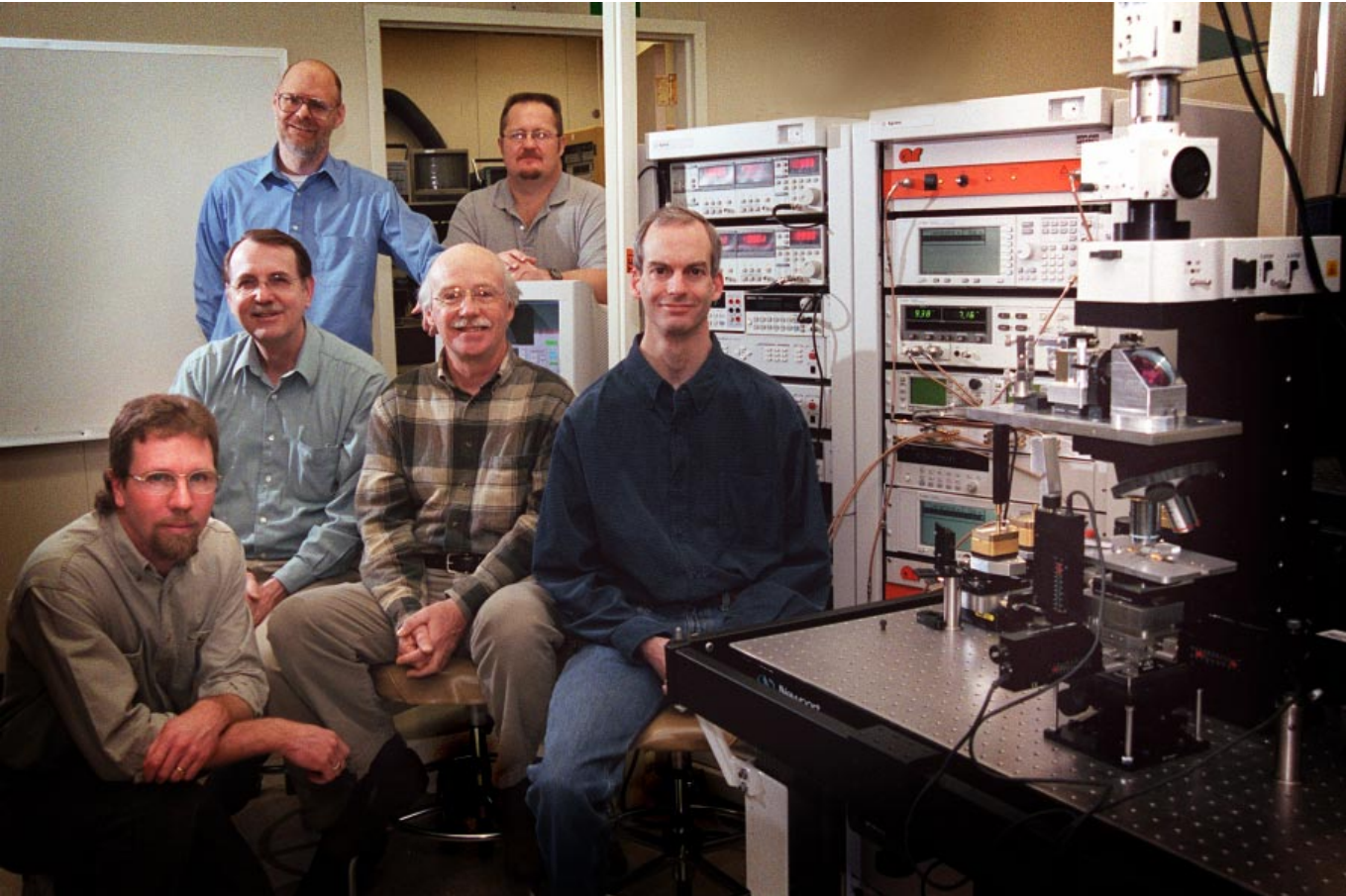


To solve it—first see it

Industry’s mantra today is “make it smaller and more powerful.” Consumers want lighter-weight laptops, sleeker cell phones that do e-mail, photography and video

games, and wristwatches with enough computing power to navigate a space shuttle. But as machines get smaller, it’s harder to find and solve functional and quality problems.

According to INEEL physicists Ken Telschow and Vance Deason, the simple answer to industry’s problem is a microscope that magnifies and images vibration instead of light. So, they designed their Real-Time Acoustic Imaging Microscope (RT-AIM) to collect a whopping 275,000



Microscope team members: Dave Cottle (kneeling, front row), Ken Telschow (second row, far left), Vance Deason (second row, middle), Robert S. Schley (second row, far right), John Walter (back row, far left), Scott Watson (back row, in doorway)

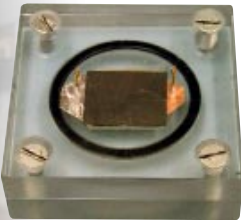
data points per second from a sample surface, and then generate a picture of the data on a video screen. What’s more, there’s no special training needed to run the microscope—no special sample preparation and no time lost painstakingly positioning the sample. Just set it on the microscope, turn on the laser, and watch (literally) the data take shape.

The microscope works by capturing a picture of natural or forced vibrations that may only be moving a millionth of a millimeter. Though it may look perfectly still, all matter vibrates—from pennies to socks to eyeglasses. And these vibrations, called acoustic waves, carry information that researchers can use. For example, acoustic waves of a penny may show that one edge is more worn than the other, or that corrosion has pitted the penny’s surface.

The team’s RT-AIM is already being put to work on Micro Electro Mechanical Systems (MEMS), tiny sensors and instruments being developed for everything from anthrax detectors—“Labs on a Chip”—to collision detectors for air bags. MEMS must vibrate in specific ways to do their various jobs. INEEL’s RT-AIM microscope is a quick, easy way to gather performance data on these types of devices in an industrial production setting. INEEL’s first customer for RT-AIM is Agilent Technologies.

(For more information, call Deborah Hill, 208-526-4723.)

Blending better batteries



INEEL chemist Mason Harrup works with a polymer solution as part of his lithium battery research.

What do you get when you mix a ceramic powder with a gooey thick oil called MEEP? An inorganic version of plastic kitchen wrap that can make batteries work better.

INEEL chemists Mason Harrup, Fred Stewart and Thomas Luther are developing the “next generation” of rechargeable lithium battery using what looks like kitchen wrap—

actually a translucent, flexible membrane called a molecular composite. Their membrane solves the major battery-life storage problem—losing power while still on the shelf.

The INEEL membrane stops this power drain by preventing electricity from “leaking” from one electrode to the other, which neutralizes the battery’s charge. At the same time, the membrane encourages maximum “flow” of positive ions, and that makes for a stronger battery.

Although they’re not ready to look for investors just yet, they’re getting closer. It’s taken the team five-and-a-half years to get this far, and Harrup estimates they have another two years of work to go. “Then we’ll be ready to talk to someone about a factory to make 10,000 batteries at a time,” he said.

Optimistic that the INEEL battery design will ultimately change the

battery industry, Harrup emphasizes that since the membrane is a flexible solid, it can be molded into any shape, which could open up new battery applications. Additionally, the membrane is very temperature tolerant, with the potential to solve portable power needs in the frigid cold of space.

As this article goes to press, the team will have submitted the fourth patent application to protect their battery design. After each patent is awarded, “we publish all the explicit scientific details” in technical journals so that other scientists can follow the work, said Harrup. The team published a major paper in the April 2003 issue of the Journal of Physical Chemistry B, describing how lithium ions move through the flexible membrane that powers their rechargeable lithium battery.

(For more information, call Deborah Hill, 208 526-4723)

INEEL achieves \$40 million in savings, cost efficiencies

It sometimes pays to re-examine the way you do things. The Department of Energy’s Idaho National Engineering and Environmental Laboratory found it paid off handsomely – \$40 million over an 18-month period in savings

and cost efficiencies. Much of the money has been reinvested in high-priority environmental cleanup work. The reinvestment has given the DOE more value for each dollar budgeted. The INEEL has applied a successful industry “best practice” known as Six

Sigma to examine a broad range of its business processes. Six Sigma starts with the idea that day-to-day work can be performed more efficiently. But Six Sigma does more than just reduce operating costs. It makes operations more effective through improved work quality and by reducing the time it takes to perform jobs without compromising safety or reducing compliance with regulations. “We use Six Sigma like a pair of

scissors to carefully cut out unnecessary activities so employees can focus on work that matters,” said Paul Rosenkoetter, INEEL Management Systems Restructuring vice president. Examining how the INEEL does its business will be an ongoing process as it goes about the job of tackling the nation’s challenges of finding solutions to energy, national security and environmental issues.

New INEEL initiative to improve energy, economic security

Who hasn't wistfully smiled while pondering the mysterious technology Rumpelstiltskin must have used to convert straw into something as wonderful and reassuring as gold—only to be disappointed by the fanciful tale?

Far from a make-believe world, scientists like INEEL's bioenergy research lead Tom Foust and his team of engineers and scientists are intensifying efforts to further develop the reality of converting straw and corn stalks into a new energy source and a future cash crop.

According to Foust, the INEEL recently created the Bioenergy/Bioproductions Initiative to focus even more attention on its bioenergy research that is steadily growing in national prominence.

The INEEL initiative is tied to a biomass program jointly sponsored by the U.S. Departments of Energy and Agriculture.

"One aspect of this national program is that it creates a unique customer-driven business opportunity," Foust said. "And under DOE's purview, the INEEL – in collaboration with the Oak Ridge National Laboratory – is responsible for preparing a research and development roadmap to set the stage for establishing this new market and providing a steady stream of feedstock for commercial biorefineries."

"This is a fresh initiative," said Foust, "aimed at increasing America's energy self-reliance and sustaining economic security in rural areas. It's simply about creating a market for straw and corn stalks that are usually plowed under or burned."

Among major challenges in using straw and corn stalks as

feedstock for fuels is the difficulty of separating and collecting the desired stalk components during harvest operations. INEEL engineers are using a suite of advanced fluid dynamics techniques – including particle image velocimetry, flow visualization and computational models – to solve the dilemma.

"The goal of this research," said INEEL researcher Kevin Kenney, "is to be able to design a harvester that will simultaneously harvest the grain and the desired portion of the straw or corn stalk in a single pass. This technology will benefit growers by eliminating the cost of a separate feedstock harvest and also enable growers to harvest their straw or corn stalks in a form suitable for conversion to fuels and other products."

"We've conceptually demonstrated, through computational modeling and test-bed engineering, that by using science-based solutions we can potentially save growers up to fifty percent of the cost to produce biomass

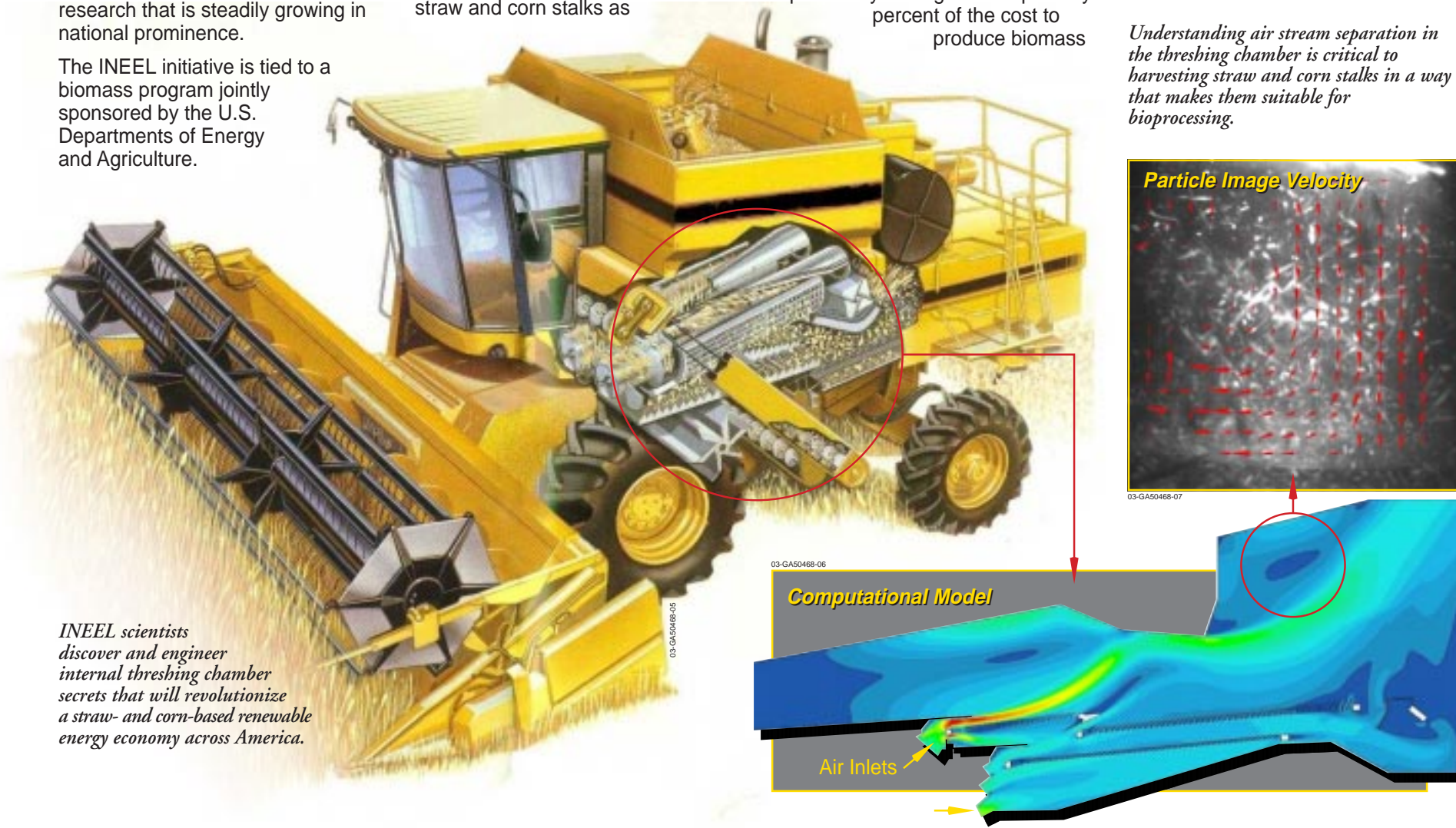
feedstock for this new industry," added Reed Hoskinson, chief harvesting engineer. "Farmers could make a \$10- to \$20 profit for each ton of feedstock."

Because a single feedstock supply system won't work for every region and cropping system around the country, explained Richard Hess, chief biomechanical engineer, key producers, manufacturers and processors from the Boise, Chicago, Minneapolis and Oklahoma City areas are being invited to collaborate with the INEEL to make this a profitable venture.

"It's through this kind of interaction, that we can identify the requirements and development priorities for clean low-cost harvesting systems, feedstock storage logistics, efficient transportation networks and policy issues," Hess said.

(For more information, call Reuel Smith, 208-526-3733.)

Understanding air stream separation in the threshing chamber is critical to harvesting straw and corn stalks in a way that makes them suitable for bioprocessing.



INEEL scientists discover and engineer internal threshing chamber secrets that will revolutionize a straw- and corn-based renewable energy economy across America.

INEEL technology moves to the marketplace

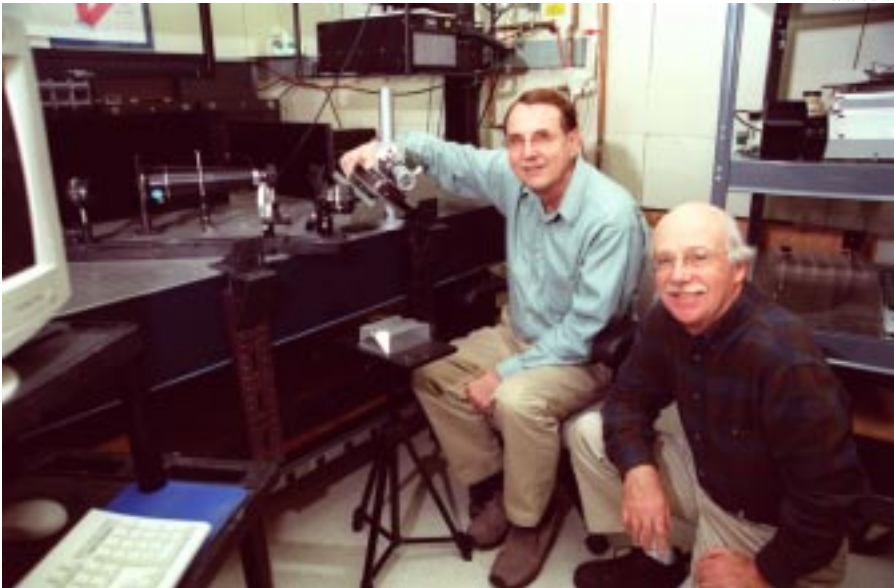
A mission of a national laboratory, such as the Department of Energy's Idaho National Engineering and Environmental Laboratory, is to put science to work to help solve some of the nation's grand challenges and to expand the frontiers of science and technology.

One of the ways the INEEL is achieving this mission is by moving its innovative technology developments into the marketplace. Methods used include collaborating with other laboratories and businesses, licensing Laboratory technologies to businesses and spinning off its technologies into new businesses.

INEEL President and Laboratory Director Bill Shipp noted at the recent Seventh Annual INEEL Inventors' Banquet that patents of inventions are a measure of a laboratory's vitality, prestige and a recognition of its outstanding research capabilities.

Last year, the combined work of 67 INEEL engineers and scientists led to 30 invention patents. In the past seven years, the INEEL has 162 patented inventions to its credit. The inventions benefit industries from energy to agriculture, and environmental cleanup to industrial production.

See **Tech Transfer** Page 7



Vance Deason (right) and Ken Telschow patented a technology that extends the usefulness of the INEEL Laser Ultrasonic Camera to discovering buried defects or other internal features in solid objects.

INEEL expands nuclear energy research role

The Department of Energy's Idaho National Engineering and Environmental Laboratory is working to fulfill its role as the nation's leading center for nuclear energy research and development.

The INEEL's newly broadened nuclear energy mission is to develop advanced nuclear technologies that provide clean, abundant, affordable and reliable energy to the United States and the world. Some of the areas of future focus include the next generation of nuclear energy development, advanced fuel cycle development and space nuclear power and propulsion applications.

These new assignments build on the INEEL's unparalleled background in nuclear energy. The INEEL is where

DOE and its predecessor agencies designed and built and operated 52 mostly first-of-their-kind nuclear reactors. The INEEL was the site where the world's first usable amount of electricity was generated from nuclear power. For many years, the INEEL was the site of the largest concentration of nuclear reactors in the world. Notable among these Idaho reactors were Experimental Breeder Reactor-I, Materials Test Reactor, the U.S. Navy's first prototype nuclear propulsion plant, Engineering Test Reactor and the world's most capable test reactor, the Advanced Test Reactor, which is still in operation at

the INEEL. The INEEL also supported the early development of commercial nuclear power with codes and confirmatory tests.

In April, Sen. Larry Craig (R-Idaho) announced he is working on legislation to authorize funding for development and construction of an advanced technology nuclear reactor at INEEL for cogeneration of electricity and hydrogen. "We began a long process back in 1997 when the nuclear energy research and development budget had reached the low point of essentially being zeroed by the previous administration. We have worked hard since then to build the country's nuclear capabilities back up, and this provision is further commitment to that," Craig said in announcing his legislation. "I thank

Energy Secretary Spencer Abraham for his support in designating INEEL as DOE's nuclear energy technology command center... We still have a lot of work to do to make this project a reality, but this is a significant step along the way and I am excited about what the future holds."

The INEEL is also a leader in the Generation IV International Forum (GIF). The forum is a group of 10 international government entities with the goal of cooperation related to the development of new nuclear energy systems.

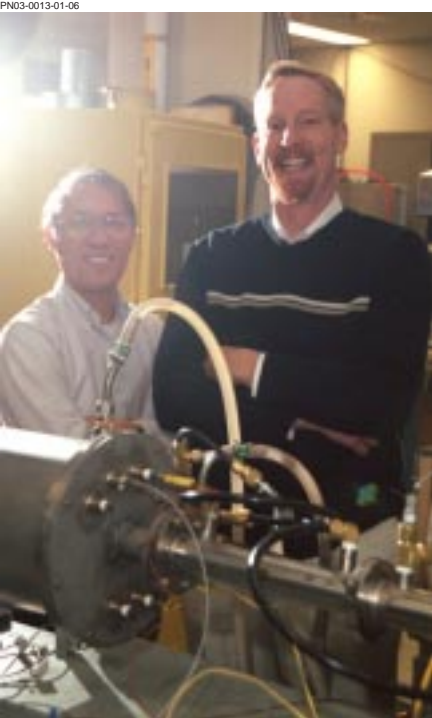
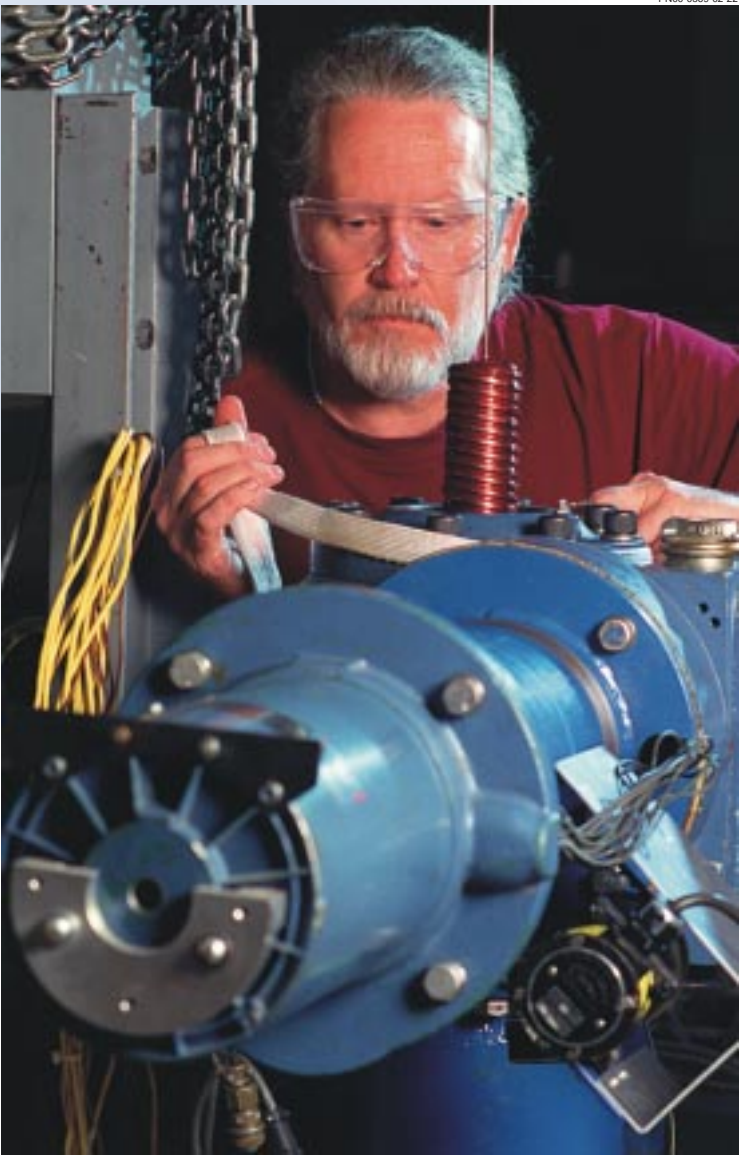
Late last year, six nuclear reactor concepts were identified by GIF as having the most potential for research and development. The six concepts are the Very-High Temperature Reactor (VHTR), a graphite-moderated, helium-cooled reactor with a once-through uranium fuel cycle; Gas-Cooled Fast Reactor (GFR), a fast-neutron-spectrum, helium-cooled reactor with a closed fuel cycle; Supercritical Water-Cooled Reactor (SCWR), a high-temperature, high-pressure water-cooled reactor that operates above the thermodynamic critical point of water; Lead-Cooled Fast Reactor (LFR), a fast-spectrum lead or lead/bismuth cooled reactor and a closed fuel cycle; Sodium-Cooled Fast Reactor (SFR), a fast-spectrum, sodium-cooled reactor and closed fuel cycle; and Molten Salt Reactor (MSR), which produces fission power in a circulating molten salt fuel mixture with an epithermal-spectrum reactor and a full actinide recycle fuel cycle.

The INEEL is researching several reactor design concepts selected by the international group.

While it is transitioning from environmental programs to nuclear energy programs, the INEEL will maintain its multi-program national laboratory status to broadly serve ongoing and future DOE and national needs. The INEEL is committed to cleaning up the nuclear waste residing at the Site as outlined in the Idaho Settlement Agreement and other compliance agreements.

(For more information, call Teri Ehresman, 208-526-7785.)

Kevin DeWall tests a motorized valve for use in nuclear reactor technology (right). The INEEL is also investigating centrifugal contactors as part of advanced fuel cycle technologies (below). Molten salt is being tested as part of the fusion safety program (bottom).



Tech Transfer

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For instance, INEEL technologies patented in 2002 could reduce pollutant emissions from two-stroke gasoline engines, help farmers better control and more efficiently manage seed planting, give the energy industry a method for separating and liquefying gases from a mixed gas stream and improve industrial welding processes.

Previously developed INEEL technologies successfully moved into the private sector include a system licensed to Positron Systems, Inc., Boise, that allows the inspection of

Brent Detering (right) and Peter Kong patented a technology in 2002 that can convert hydrocarbons into a substantially clean-burning hydrogen fuel that produces no greenhouse gas emissions.

structures and materials to detect degradation before a failure occurs. A system, which uses liquid nitrogen as a cutting tool that doesn't create additional waste, has been licensed to NitroCision, LLC, headquartered in Idaho Falls.

Another way the INEEL puts technology to work is through spin-off companies, and the INEEL had two last year. The NanoSteel Company is based on a metallic spray-coating technology that creates the hardest metallic coating known. It has attracted interest from hundreds of companies nationally. TetriDyne Solutions, Inc. specializes in software that allows various computer software and systems to better communicate.

Sometimes, an INEEL technology has the potential to benefit industry, but the technology isn't yet ready to

go to market. Through a collaboration mechanism called a Cooperative Research and Development Agreement, the INEEL forms partnerships with industries to continue the research and prepare technology for transfer to the private sector. CRADA projects under way include developing a ceramic membrane system for production of synthetic gases, and research into a system for detecting potato disease.

Lyman Frost, INEEL director of Technology Transfer and Commercialization, said, "Our people consistently deliver inventions with a wide variety of scientific, industrial and environmental applications needed in the world today. Their ideas and inventions are laying the foundation for the Laboratory's future."

(For more information, call Steve Zollinger, 208-526-9590.)

INEEL scientists bring in \$6 million for nuclear energy research

The position of the Idaho National Engineering and Environmental Laboratory as the nation's premier nuclear energy technology center continues to grow.

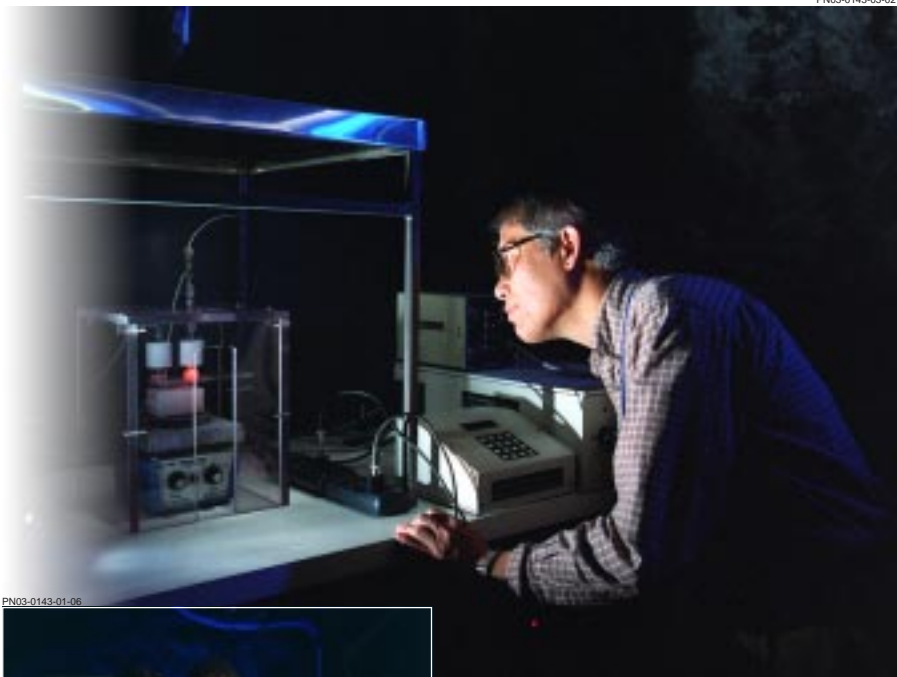
INEEL researchers recently racked up eight awards for nuclear research: three lead and four support awards sponsored by the DOE's Nuclear Energy Research Initiative (NERI) and another funded by the DOE's Office of Energy Efficiency and Renewable Energy. The awards will inject \$6 million into INEEL's nuclear research efforts over the next three years, bolstering an array of technological advances in nuclear reactor design and the nuclear-assisted production of hydrogen as a transportation fuel.

INEEL nuclear engineer Abderrafi Ougouag, recipient of two NERI awards this year, sums it up: "The nature of progress is to do better work with better tools year after year. The NERI awards will allow us to create the tools needed to devise safer and more economical reactors for the benefit of the U.S. and all humanity."

The NERI support contributes to securing INEEL's status as the leading institution in many areas of nuclear research and design. What's more, INEEL scientists foresee their contributions to nuclear innovation making a real difference in people's everyday lives. "Our work has the potential to pay off—increasing the standard of living worldwide—in the next 10 years," says nuclear engineer William Terry. "It could provide affordable electricity to people who today have none."

INEEL nuclear engineers Kevan Weaver, Jim Sterbentz and Jacopo Buongiorno, along with colleagues at the Massachusetts Institute of Technology, will pursue a process that promises to make fast spectrum reactor types even better by significantly reducing the need for fuel recycling.

The team's research will boost a reactor's fuel-burning efficiency,



Peter Kong experiments with efficient ways to generate hydrogen (above). Kevan Weaver (far left) and Denis Clark test a special welding machine to study ways to join advanced materials for use in the next generation of nuclear reactors.

stretching uranium resources for greater energy production. To put this in perspective, Weaver says, "It's like finding a way to use gasoline more efficiently. If you get 50 miles to the gallon now, with the new technology, you would get 500 miles per gallon."

Four of the projects set out to improve the performance of the modular pebble bed reactors (PBRs)—an attractive next-generation reactor type because of its potential high fuel economy and virtual safety.

Ougouag—along with fellow INEEL nuclear engineers Hans Gougar and Terry and their collaborators at Georgia Tech, the South African company PBMR (Pty.) Ltd., Penn State, and the University of Arizona—are developing a pebble bed nuclear

reactor physics model to predict the behavior of the neutron chain reaction in the PBR core as the fuel burns. Their goal is to evaluate the advantages of particular reactor designs in terms of their safety, proliferation resistance and fuel economy, and to make optimal decisions about their operation.

Support awardees David Petti and Greg Miller, INEEL nuclear engineers, are collaborating with Oak Ridge National Laboratory to design coatings that improve PBR fuel integrity.

INEEL chemical engineer Chang Oh, along with fellow INEEL researchers Richard Moore and Richard Wright, received an award to investigate a new power conversion cycle for a PBR. The design would increase the thermal efficiency by 15 percent by using supercritical carbon dioxide.

The high temperature of the next generation of many reactors has a potential side benefit—it will generate enough heat to enable hydrogen production by splitting water through a thermo-chemical or thermoelectrical process, Oh says. President George W. Bush has envisioned that hydrogen will become the primary fuel source for cars in the future as fossil fuel resources dwindle.

"As INEEL takes the lead in Generation IV reactor development, it's natural that we get into this since the high temperatures of advanced reactors are ideally suited for hydrogen-generating chemical reactions," nuclear engineer Ed Harvego said.

Today, industry obtains the majority of its hydrogen from steam reforming of natural gas, Harvego notes. But that method produces greenhouse gases that contribute to global warming, and the demand for hydrogen will soon outstrip the fossil-fuel-derived supply. To address the problem, Harvego has teamed up with General Atomics in San Diego, along with Texas A&M University and Entergy Nuclear, Inc., to create a design for hydrogen production with a modular helium reactor.

Another method of hydrogen generation is to split water with electrolysis. Current methods of electrolysis, though reliable, are energy intensive. Steve Herring will lead an INEEL research team that includes Carl Stoots, Paul Lessing and Jim O'Brien, to develop a more efficient method of breaking up water molecules using heat and electricity generated from nuclear reactors.

Gas stations might soon be converted to sodium borohydride stations, if the vision of INEEL nuclear engineer Peter Kong and Herring becomes a reality. Their lead proposal seeks to develop a method of converting sodium borate into sodium borohydride fuel—a safe and efficient means of storing and transporting hydrogen in liquid form—using plasma technology and the heat and electricity generated from nuclear reactors.

(For more information, call Teri Ehresman, 208-526-7785.)

INEEL continues its support of state economic development

A major manufacturer has relocated to northern Idaho, a start-up business opened its doors in southeast Idaho and a national company established a service center in Twin Falls. These are all results of efforts in recent months by the U.S. Department of Energy's Idaho National Engineering and Environmental Laboratory to support economic development in the state.

"Economic development throughout Idaho is a commitment that is taken seriously by the INEEL, and we're committing not only the economic development dollars, but also the time of our employees," said Bill

Shipp, INEEL President and Laboratory Director.

For example, an INEEL \$100,000 grant supported the relocation of the Buck Knives manufacturing operations from California to Post Falls, Idaho. The INEEL collaborated with the state of Idaho, which will provide funds for employee training, and Jobs Plus in Coeur d'Alene on the business's move. The result will be 225 jobs and a new 110,000-square-foot building in Post Falls.

An INEEL grant of \$30,000, combined with efforts of Bannock Development Corporation, helped the wireless communications company ClearTalk Communications defray start-up costs for its new office in Pocatello. ClearTalk employs some 30 people in the Pocatello home office and others stationed in Bonneville, Bingham, Lemhi and Blaine counties.

INEEL also donated \$50,000 in ongoing support to the Magic Valley Business Plus II economic development organization. The organization was successful last summer in bringing a satellite technical support center for Dell Computer to

Twin Falls. The center provides several hundred technical jobs and more than 30 managerial positions.

Money for these grants and other assistance throughout Idaho comes from Bechtel BWXT Idaho, LLC, the management and operating contractor at the INEEL. BBWI has an annual budget of \$1.4 million furnished by the corporate partners to assist in economic development. These funds are corporate dollars not connected with any government or private-entity funds used in research and operations of the INEEL.

Statewide, the INEEL has created about 3,000 jobs not related to the Laboratory since October 1999, when Bechtel BWXT Idaho, LLC became management and operating contractor.

(For more information, call Steve Zollinger, 208-526-9590)

